LEARN NC

Bounce into rubber: Natural latex from Thailand

This lesson for grade nine investigates natural latex rubber sources from Thailand. Students complete research and experiments to determine which plants from Thailand are sources of latex, and explore images and audio recordings of rubber harvesting in Thailand.

A lesson plan for grades 7 and 9 Science and Social Studies

BY ROBIN BARTOLETTI

Rubber latex is one of the most important products to come out of the rainforest. Thailand is a major world supplier of natural rubber latex. More than 2,500 species of plants produce natural latex. Many of these plants are trees grown in tropical climates. Some of those plants come from Thailand. In this lesson, students will conduct online and lab research and two experiments to answer these questions: What is natural rubber latex? What are its properties? What kind of plants from Thailand produce rubber? Where do they grow? What is the process for extracting rubber from plants? What other plants contain latex?

On a rubber tree plantation, white (Photograph by Margery H. Freem

Learning outcomes

Students will:

- understand the properties of natural rubber latex, how sap is harvested, and how rubber is formed from tree sap
- make observations and complete research of the properties of latex rubber
- determine if sap gathered from plant samples is latex rubber
- identify plants that produce natural rubber latex
- identify rubber latex-producing plants that can be found in Thailand and where those plants grow within the country

Teacher planning

TIME REQUIRED FOR LESSON

Three 60-minute class periods

MATERIALS NEEDED

- Computer with projector
- Student computers with internet access
- Images and audio recordings of rubber production in Thailand from the LEARN NC multimedia collection (See listing below under "Activity three: Discovering the latex rubber process." **Note:** Printed copies of the images may be used if there is no access to computers or multimedia projector.)
- Student handouts:
  - Group experiment log
  - Outline map of Thailand
- Paper cups
- Sample plants (see listing below under "Plant Samples")
- Safety knives
- Safety glasses
- Measuring spoons
- Craft sticks
- Measuring spoons
- 10 cups liquid latex (**Note:** Liquid latex may be purchased from scientific suppliers such as Flinn Scientific.)
- Bottle of vinegar
- Sandwich baggies
- Several buckets or bowls (one for each group, at least 5 cups)
- Water
- Paper towels
- Glue sticks
- Markers or colored pencils

Learn more

RELATED PAGES

- Mix and match ecology: Symbiosis: In this high-school biology lesson, students gain an understanding of the three kinds of symbiotic relationships by creating relationships between imaginary animals.
- Family gardening in rural North Carolina: This lesson for grade one uses a series of activities related to plants and gardening to help students learn about gardening, plant life, families, and making

Pre-activities

- Familiarize yourself with Thailand by reading sites such as the CIA World Factbook's overview of Thailand, encyclopedias, or other reference sources. (For more suggestions, see "Websites" below.)
- Familiarize yourself with natural latex, which is the protective fluid contained in tissue beneath the bark of the rubber tree, *Hevea brasiliensis*. The tree originated in Brazil, and latex was originally gathered from wild trees in the jungles of Brazil in the 1870s. Thailand now has extensive rubber tree plantations and harvests latex. For more information about natural latex, see "Websites."
- You may also want to familiarize yourself and your students with the vocabulary listed with this lesson plan.
- Collect needed materials, including plant samples, before the lesson.

PLANT SAMPLES

Plant samples used should include at least some of the following latex-producing plants. Other non-producing samples can also be included. All plants should be identified by the instructor but not the students before distribution to groups.

- Milkweed (*Asclepiadaceae*) **IMPORTANT: Milkweed sap contains a toxin that is a powerful eye irritant. Have students wear safety goggles when handling milkweed and ensure that they wash their hands afterward.**
- Sunflower (*Helianthus annuus*)
- Hevea rubber tree (*Hevea brasiliensis*)
- Dandelion (*Taraxacum officinale*)
- Guayule (*Parthenium argentatum*)

To find suppliers of plants in your area, consult the Wildflower Center from the University of Texas at Austin.

SAFETY PRECAUTIONS

- People with a latex allergy should not do this laboratory.
- Liquid latex is packaged in ammonia which acts as a preservative. Neutralization with vinegar (acetic acid) will cause the latex to solidify into rubber very quickly. The ammonia and vinegar have irritating fumes, but latex is not considered hazardous. Students should wear safety goggles or glasses at all times in the laboratory.
- Milkweed sap contains a toxin that is a powerful eye irritant. Have students wear safety goggles when handling milkweed and ensure that they wash their hands afterward.
- **Disposal:** Materials can be safely disposed of in the trash.
- **Clean-up:** Latex spilled on non-porous surfaces can be allowed to dry and then peeled off. If spilled on clothing, a dry cleaner can often remove most of a latex stain.

Activities

ACTIVITY ONE: IS IT RUBBER LATEX?

Part 1

1. Introduce the lesson by sharing background about natural latex with students:

   > Natural rubber is an elastic hydrocarbon polymer called *polyisoprene* and is found in the sap of certain plants. The most commonly known source of natural rubber is the rubber tree (*Hevea brasiliensis*), which originated in Brazil and now grows in East Asia and tropical Africa. However, rubber latex can be found in the inner bark of many other plant species. Some of these are the sunflower, milkweed, and the guayle shrub. Natural latex, a sticky white sap, oozes out of these plants when they are cut.
   >
   > Latex turns into a rubbery mass within 12 hours after it is exposed to the air. Natural rubber latex is a cloudy white liquid, similar in appearance to milk. It is collected by cutting a thin strip of bark from the tree and allowing the latex to exude into a collecting bucket or bowl over a period of hours.

2. Divide students into groups of five, and give each group the following materials:
   - Five-ounce paper cup
   - Sample plant
   - Safety knife
3. Instruct students to harvest sap from the sample plants by making a small cut in the bark or stem. When the milky-substance called latex flows out, each group should place its sample plant across the top opening of the paper cup and make several cuts. The stem should be placed so that the sap drips into the paper cup.
4. Ask students to observe the sap. What does it look like? What does it smell like? Instruct students to describe its properties on their group experiment logs. Tell students that they will leave the cups of sap in the open air for at least 12 hours. They should observe whether the sap solidifies into a rubbery mass, and then decide if they think it is natural rubber latex. Students should compare the physical properties of the sap they collect and the air-exposed sap to the physical properties of natural latex rubber. Remind students that natural rubber is one of the more unusual materials found in nature. It can be stretched and it snaps back to its original shape. It's also waterproof.

healthy choices.

- Hands-on biology: Hands-on science exploration clarifies difficult concepts and engages learners who have difficulty in more traditional classrooms. This article looks at an inquiry-based classroom that meets the needs of all of its students.

RELATED TOPICS

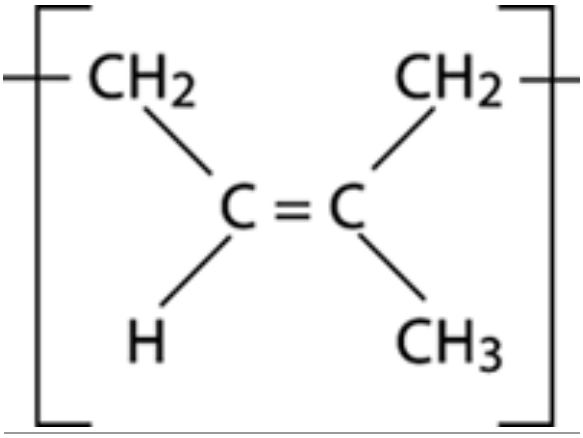
- Learn more about Asia, Thailand, biology, cooperative learning, discovery learning, hands-on, latex, rubber, rubber tree, science, and world cultures.

Help

Please read our disclaimer for lesson plans.

Legal

Natural rubber's scientific name is polyisoprene, and it has the following chemical structure:



Students can use the following resources to learn more about the properties of natural latex rubber:

- Natural Rubber from Buzzle.com
- Rubber from the *Academic Kids Encyclopedia*
- Wikipedia article about natural rubber
- Wikipedia article about the Pará Rubber Tree
- "Everything You Ever Wanted to Know about Rubber" website
- Answers.com article about rubber

5. Have the students leave their cups of sap to observe after 12 hours.

Part 2

1. Have students use reference sources to try and identify their plant species, and instruct them to record their deductions on the group experiment log. Some suggested resources follow:
   - Academic Kids Encyclopedia — see guayule, Para rubber tree, dandelion, *Asclepias* (milkweed), sunflower
   - Plant database from the United States Department of Agriculture
   - Tropical plant database from Raintree Nutrition
   - Flora of Thailand from Wikimedia
   - McMakin, Patrick D. *Flowering Plants of Thailand: A Field Guide.* White Lotus Ltd., 2000. — Worldcat record
   - Engel, David and Phummai, Suchart. *A Field Guide to Tropical Plants of Asia*. Timber Presss, 2002. Available via Google books
2. Review the students' identifications and see if any of the plants have been identified correctly. You may use library references or the resources listed above to show images of the correct plants.

ACTIVITY TWO

Part 1: Coagulation of rubber latex

1. Hand out the following materials to each group:
   - Tablespoon measuring spoon
   - 1 tablespoon liquid latex
   - Craft stick
   - Sandwich baggies for squeezing out excess liquid
   - Two 5-ounce paper cups
   - Small bucket or bowl (2 cups or larger)
   - 4 teaspoons vinegar
   - 4 teaspoons water
   - Paper towels
2. Tell students that liquid latex is often mixed with water and acid to make it thicker. This process is called coagulation. Mixing latex with vinegar (acetic acid) will cause the latex to solidify into rubber very quickly.
3. Give the students the following instructions:
   1. Add 1 tablespoon of latex into a paper cup.
   2. Measure 1 tablespoon of water and stir it into the latex with your stick.
   3. Stir the mixture.
   4. Observe closely as you add 1 tablespoon of vinegar and stir. Record any observations on your experiment log. Describe in detail any changes you notice when you add vinegar to your mixture of water and latex.
   5. Use your fingers to remove the mass from the cup and remove the stirring rod. Carefully squeeze the mass while washing it under water in a small bucket or bowl. Form the mass into a ball. Dry it with a paper towel. Drop the mass on the floor and describe what happens.

6. Describe the polymer on your experiment log.

Part 2: Where does the rubber grow?

1. Introduce this part of the lesson by giving students the following background information:

   > The invention of the automobile increased the demand for rubber, and by 1914 wild rubber plants could not supply enough. Rubber plantations were established in Africa, Central and South America, and in Asian countries such as Indonesia, Thailand, Vietnam, and the Philippines. The cultivated rubber trees produce more latex than the wild trees. Today, more than 80% of the world's natural rubber is grown in Thailand, Indonesia, and Malaysia. The *Hevea Brasiliensis* tree from which latex is harvested is most productive within a narrow belt extending about 700 miles on either side of the equator. About 100 trees are planted per acre. Rubber trees are planted in straight rows and dot the landscape of southern Thailand.

2. Use a projector to show students a map of Thailand, and give each student the blank map of Thailand handout.
3. Have the students research the rubber tree and discover as much information as they can about where the tree grows. What kind of climate does it need to thrive? What kind of forest does it grow in?
4. Have the students get back into groups. Drawing on the information they gathered in their research, have each group look at the following maps and infer where the rubber trees are most likely to grow in Thailand. (Tip: click on the link below each image for the largest version, and then click on the map to zoom in.)
   - 1974 vegetation map of Thailand
   - Map of forest growth in Thailand
   - Forest cover map of Thailand
5. Instruct the students to color in the blank map with the locations where rubber trees would be most likely to grow.

ACTIVITY THREE: DISCOVERING THE LATEX RUBBER PROCESS

1. Introduce the activity by sharing the following information with the students:

   > Rubber trees grow best in hot, moist climates. The trees grow straight, 18-20 feet high with smooth bark and dark, shiny leaves. Rubber trees produce pale yellow blossoms, which give way to seed pods, each of which contains three brown seeds about 2-3 cm long. Latex containing rubber flows through the outer wood of the trunk, just under the bark. Workers — called tappers — collect the latex by cutting a shallow groove in the bark about three feet from the ground. At the bottom of the cut, a small spout is inserted into the tree, and a cup hangs below it to catch the drops of latex that ooze from the cut. Trees are generally tapped every day for 15 days, and then rested for 15 days.
   >
   > The latex is poured into tanks, and an equal amount of water is added. This liquid is strained to remove dirt. Formic acid is added to make the mixture form solid particles, which rise to the surface to form a crust of rubber. This is fed through rollers to squeeze out the water to make a solid sheet of rubber. This rubber is crude rubber, and is ready to be shipped to factories to be processed in different ways to make many different products.

2. Tell students that they will explore the rubber-making process in pictures and in audio recordings. They will then work in their groups to create a brochure about the process of making rubber from natural latex in Thailand. Tell the groups the brochure must be full color and must "sell" the natural rubber process. Students must include the rubber images made available in this lesson, their written text, a title or logo, some text "selling" the latex process, and any references used.
3. Pre-teach any vocabulary words that the students might need to use in order to describe their pictures and sounds.
4. Give each group access to the following images of the rubber-making process from the LEARN NC collection. (Note: the following two images are from Vietnam, but they show the same rubber-making process that is used in Thailand.) You may choose to set up a file with the digital image photos on student-accessible computers. If students don't have access to computers, you may copy the images into a Word document and hand out printed copies:
   - Rubber tree plantation located between Dalat and Ho Chi Minh City
   - White latex sap dripping into collection pan on tapped rubber tree in plantation

   For additional images of the rubber-making process, you may have the students access Rubber Production: Tapping rubber trees, latex collection and processing of raw rubber, from the website of Joseph E. Armstrong, Professor of Botany, Illinois State University. The website includes a step-by-step series of photographs of the rubber-making process.

   The following photos from Wikipedia and the Wikimedia Commons may also be used:
   - Rubber tree
   - Latex production
   - Latex dripping
   - Rubber latex
5. Have the students listen to the following audio recordings of the rubber-making process in Thailand. Before playing each recording, read the description written by the recording's creator (including the journal entries) to the students.

Instruct the students to listen and write down important information as you read, and then use their imagination to describe what is happening in the sounds they hear on the audio clips. Tell the students they will draw on the information from the recordings and their descriptions to write the content to go with their brochure images. Groups should create written descriptions of each image and put them in order. Students can use some of the rubber websites for assistance. (See "Websites" below.)

- Making rubber: Dumping and scraping pans
- Making rubber: Pressing with feet
- Making rubber: Sound of feet
- Making rubber: Loading press
- Making rubber: Pressing out the water
- Making rubber: Separating and hanging

6. Have the groups sketch out some rough ideas of how they want their brochure to look — including any graphics, clip art, titles, etc. Using either the printed images, scissors, glue, or the digital images and software, have the students try out different formats to fit their text. Have the students edit their text to fit their layout. If students are using software, have them transfer their rough sketches to the computer. Depending on the software you're using, there may be templates or wizards available to provide students with even more ideas. Students can also use their maps from part two of this lesson on their brochures.
7. Display the resulting brochures and have students discuss the rubber-making process. Ask students in what order the process happens. Have students score each other's brochures using the rubric below, under "Assessment."

Assessment

- Assess student responses and adjust questioning and activities as needed.
- Grade students on completeness of work.
- The following rubric may be used to assess the brochure in activity three. You may have student groups assess each other's brochures.

BROCHURE RUBRIC

	(4) Excellent	(3) Good	(2) Almost	(1) Not yet
Attractiveness & organization	The brochure has exceptionally attractive formatting and well-organized information.	The brochure has attractive formatting and well-organized information.	The brochure has well-organized information.	The brochure's formatting and organization of material are confusing to the reader.
Content accuracy	The brochure has all of the required information and some additional information.	The brochure has all of the required information.	The brochure has most of the required information.	The brochure has little of the required information.
Writing (mechanics)	All of the writing is done in complete sentences. Capitalization and punctuation are correct throughout the brochure.	Most of the writing is done in complete sentences. Most of the capitalization and punctuation are correct throughout the brochure.	Some of the writing is done in complete sentences. Some of the capitalization and punctuation are correct throughout the brochure.	Most of the writing is not done in complete sentences. Most of the capitalization and punctuation are not correct throughout the brochure.
Graphics/Pictures	The graphics go well with the text and there is a good mix of text and graphics.	The graphics go well with the text, but there are so many that they distract from the text.	The graphics go well with the text, but there are too few.	The graphics do not go with the accompanying text or appear to be randomly chosen.
Sources	There are many citations from a variety of sources accurately listed on the brochure.	There are some citations from a variety of sources accurately listed on the brochure.	There are a few citations accurately listed on the brochure.	Incomplete citations are listed on the brochure.

Extension

Any of the following options may be used to extend this lesson:

- Visit the Silly Putty: Synthesizing a Polymer page on the Louisiana State University Department of Chemistry website. This page in PDF format includes instructions for making Silly Putty and explains the chemistry behind it.
- Have the class read the article "Natural Rubber — History and Developments in the Natural Rubber Industry." Discuss in class how these technologies have affected the growth of the natural rubber industry.
- Mind map the uses of rubber. For specific instructions, you can use the "Many Uses of Rubber" student handout, available on the "Inventions of Necessity: Synthetic Rubber" lesson from the Science Net Links website.

Modifications and alternative assessments

For students with certain learning disabilities, teachers may opt to accept verbal responses rather than written responses for the brochure text. Teachers may also want to be sure and group students of differing abilities into groups.

Critical vocabulary

Rubber latex

The milky sap of any of several trees of the genus *Hevea*, especially *Hevea brasiliensis*, from which natural rubber is derived.

Elasticity

The ability to recover original shape and dimensions upon removal of a deforming force.

Latex

A milky fluid found in certain cells of some families of seed plants. Latex is the raw material from which rubber is made.

Acid

A chemical substance containing hydrogen with the ability to dissolve metals, neutralize alkaline materials, and combine with bases to form salts.

Rubber tree

A tropical South American tree, *Hevea brasiliensis*, that is the source of latex.

Coagulation

The process of changing from a liquid to something thicker.

Polymer

A chemical compound made up of a large number of identical components linked together like a chain.

Hydrocarbon

An organic compound containing only carbon and hydrogen.

Polyisoprene

Any polymer whose constituent monomer is isoprene; especially natural, and some synthetic, rubbers.

Neutralization

The addition of either an acid or a base to a solution as required to produce a neutral solution.

Acetic acid

The acid most commonly associated with vinegar. Acetic acid is a two-carbon carboxylic acid.

Websites

- Information about Thailand:
  - Overview of Thailand from the CIA World Factbook
  - Thailand fact sheet from the Common Language Project website
  - Overview of Thailand from the website of the Royal Thai Embassy in Washington, D.C.
- Information about natural latex rubber:
  - Rubber Production: Tapping rubber trees, latex collection and processing of raw rubber, from the website of

Joseph E. Armstrong, Professor of Botany, Illinois State University — includes a series of photos explaining the rubber-making process
    - Natural Rubber from Buzzle.com
    - Rubber from the *Academic Kids Encyclopedia*
    - Wikipedia article about natural rubber
    - Wikipedia article about the Pará Rubber Tree
    - "Everything You Ever Wanted to Know about Rubber" website
    - Answers.com article about rubber
- For national suppliers of plants, consult the Wildflower Center from the University of Texas at Austin.
- Liquid latex may be purchased from Flinn Scientific
- Suggested resources for identifying plants:
    - Academic Kids Encyclopedia — see guayule, Para rubber tree, dandelion, *Asclepias* (milkweed), sunflower
    - Plant database from the United States Department of Agriculture
    - Tropical plant database from Raintree Nutrition
    - Flora of Thailand from Wikimedia
    - McMakin, Patrick D. *Flowering Plants of Thailand: A Field Guide.* White Lotus Ltd., 2000. — Worldcat record
    - Engel, David and Phummai, Suchart. *A Field Guide to Tropical Plants of Asia*. Timber Presss, 2002. Available via Google books

North Carolina curriculum alignment

SCIENCE (2005)

Grade 9–12 — Biology

- **Goal 1**: The learner will develop abilities necessary to do and understand scientific inquiry.
    - **Objective 1.01**: Identify biological questions and problems that can be answered through scientific investigations.
    - **Objective 1.02**: Design and conduct scientific investigations to answer biological questions.
        - Create testable hypotheses
        - Identify variables.
        - Use a control or comparison group when appropriate.
        - Select and use appropriate measurement tools.
        - Collect and record data.
        - Organize data into charts and graphs.
        - Analyze and interpret data.
        - Communicate findings.
    - **Objective 1.04**: Apply safety procedures in the laboratory and in field studies:
        - Recognize and avoid potential hazards.
        - Safely manipulate materials and equipment needed for scientific investigations.

North Carolina Essential Standards

- **SCIENCE (2010)**

    Biology

    - Bio.2.1 Analyze the interdependence of living organisms within their environments. Bio.2.1.1 Analyze the flow of energy and cycling of matter (water, carbon, nitrogen and oxygen) through ecosystems relating the significance of each to maintaining the health...

- **SOCIAL STUDIES (2010)**

    Grade 7

    - 7.E.1 Understand the economic activities of modern societies and regions. 7.E.1.1 Explain how competition for resources affects the economic relationship among nations (e.g. colonialism, imperialism, globalization and interdependence). 7.E.1.2 Explain the...
    - 7.G.1 Understand how geography, demographic trends, and environmental conditions shape modern societies and regions. 7.G.1.1 Explain how environmental conditions and human response to those conditions influence modern societies and regions

(e.g. natural barriers,...